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Evaluation of Yam Starch (*Discorea rotundata*) as Aquatic Feed Binder

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Abstract: This experiment was conducted to evaluate the suitability of yam starch as a local alternative binding agent in aquatic feed, which is effective and nutritive. The binding property of yam starch in feed pellet, increased significantly with the levels of inclusion in fish feed production. Five percent (5%), inclusion level was found to be appropriate in producing desirable water stable pellet that is also firm to handling during transportation and storage.

Key words: Yam starch, binder, aquatic feed

INTRODUCTION

Nigeria is abundantly endowed with the root crop-Yam (*Dioscorea rotundata*) of which is obtained the bidding agent yam starch. The bidding capability of yam starch discovered has the potential of boosting aquacultural sub-sector of the economy.

On-Farm aqua feed unlike livestock feed requires adequate level of processing to guarantee optimum availability to and utilization of compounded feed by the target fish (Misra *et al*., 2003). Such a feed should be firm to handling as well as maintain reasonable degree of stability in the aquatic medium, long enough for fish to consume it (Wood, 1993; Pigott and Tuker, 1989; Pigott *et al*., 1982; Fagbenro and Jauncey, 1995; Misra *et al*., 2003).

Such a stable pellet feed will allow for wholesome delivery and utilization of feed materials for the fish unlike as experienced in the broadcast method, leaching of nutrients will be minimized (Sadiku and Jauncey, 1995; 1998; Tiamiyu *et al*., 2003 a, b). The role of binder in aqua-feed is significant but the high cost of conventional synthetic binders make pellet feed production at on-farm level a difficult exercise especially for small and medium scale aqua culturists, thus, most farmers result to arbitrary inclusion of any available unconventional binding agents in the production of the pellet feed at any level of inclusion of binder. Aside from establishing the range of natural binders from 0-20% (Jauncey, 1992), there has not been any significant research into such natural binders as yam.

Moreover, the establishment of the appropriate level of yam starch inclusion, in addition to other local binders such as cassava starch (Asiedu, 1992), arrow root, potato starch (Wood, 1993), corn starch (Orire *et al*., 2001), etc will go a along way in addressing the problem confronting fish farmers at on-farm level of aquatic feed production. The binder level that will give desirable pellets (Hastings, 1980) as well as that will ensure wholesome delivery of nutrients to fish with minimum wastage (Viola *et al*., 1986; Natividad, 1994).

In addition, the availability of yam starch at on farm level will be an appropriate local alternative to fish-farmers. The finding would enhance aquacultural production by rendering feed production affordable and attainable at on farm level thus, reducing existing pressure on the stressed fresh and marine water bodies resources that are presently seriously threatened with extinction due to over exploitation and over-dependence on them for fish supply to teeming population of Nigerians and for export.

MATERIALS AND METHODS

Starch processing: A yam tuber of 2kg size of the variety *Dioscorea rotundata* (white yam) was peeled, washed and grated. The paste (4 litres) was then mixed with sufficient quantity of water to allow for proper exudation of the starch from the fiber. The solute was the poured into cheesecloth and squeezed to obtain the starch solution filtrate. This was then allowed to stand overnight for thorough separation. The supernatant was decanted to obtain the starch, which was dried in the sun at about 36°C for 6 hours and then packaged in 5, 10, 15 and 20 grams for incorporation in the five (5) diets.

Feed preparation and pelleting: Binder level in an existing isonitrogenous diet formula of 30% crude protein was reconstituted, with the use of Yam starch at inclusion levels of 0, 5, 10, 15 and 20% as diets 1, 2, 3, 4 and 5 respectively (Table 1).

For effective inclusion of the starch, the Yam starch was mixed in its powdery form with other feed ingredients and on which a 120% v/w boiled water was added and stirred thoroughly to obtain a good dough. The formed dough was then fed into an Atlas motorized Bohr miller (Pelleter) with a 3mm die for pellet size. The pellet strands were then cut at 5mm length; sun dried (36°C) for 6hrs and packed.

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Table 1: Percentage composition of diets with varying levels of yam starch as feed binder

	Diets				
Feedstuff	1	2	3	4	5
Soybean meal	37.26	37.26	37.26	37.26	37.26
Fish meal[1]	3.64	13.64	13.64	13.64	13.64
Corn bran	16.37	16.37	16.37	16.37	16.37
Guinea corn bran	32.74	32.74	32.74	32.74	32.74
Yam starch	0	5	10	15	20
Vit.-Min-Premis*	20	15	10	5	0
Proximate composition					
moisture	7.43	13.40	16.81	20.21	23.61
Crude protein	28.91	28.91	28.91	28.91	28.91
Ether Extract	9.9	9.9	9.9	9.9	9.9
Ash	26.19	21.19	16.19	11.19	6.19

*Vitamin-mineral premix is as contained in Sadiku and Jauncey (1995 and 1998)

Evaluation of physical properties of the pellets: The following physical tests were conducted on the pellets; pellet ability, dust level, hardness, friability and water stability.

i) **Pellet ability:** The pelleted feed was sifted to separate the well formed from the unformed. The percentage pellet ability was obtained by expressing the pellet weight to the total weight.
ii) **Hardness:** The procedure used was to determine the force required to cause a pelleted feed particle to fragment. This gives an indication of pellet's degree of hardness. To do this an improvised pentagon nut was used, by placing a pellet sample of 5mm in length longitudinally between two rods and gently tighten the grip. The pentagon nut was then turned and the calibration read against when the pellet gets broken. This was repeated for 24 more pellets and average number of turn was taken for each. The average number of was then taken for the pellets sample to ascertain its hardness.
iii) **Friability:** Fifty grams (50g) of pellet sample was put in a container and adapted into a rotary machine at different preset speed levels of rotation per minute (rpm) of 40, 63, 80 and 100 rpm at 20 minutes. The dust generated from the agitated pellets was then collected through 2mm sieve and was weighed and expressed as a percentage of the sample weight.
iv) **Water stability:** Fifty grams (50g) of pellet sample was placed in a beaker into which 200 mL of tap water was added. It was then allowed to stand with occasional gentle shaking for 20 seconds every 2 minutes. It was then passed over 2mm sieve, the particles were allowed to settled and decanted which was then sun-dried. The retained dry weight was then expressed as a percentage of the sample dry weight.
v) **Dust:** Sample pellets of fifty grams (50g) by weight and was placed under normal stress-condition, such as handling, packaging and transportation for a period of two (2) weeks. The dust particles produced was collected through a 2mm sieve and was measured as a percentage of the original weight.

Experimental design: Completely randomized block design was used to analyze parameters such as pellet ability, hardness, dust and water stability while a 5×4 factorial design i.e. 5 starch levels of inclusion in the feed×4 levels of rpm was adopted for pellet friability.

Statistical analysis: The data was analyzed using a one-way Analysis of variance (ANOVA). Also Arc-sine data transformation was done according to Zar (1984). Means comparison was done using multiple range of test (Steele and Torrie, 1960).

RESULTS

In Table 2, the pelleted yam starch (binder) exhibited significant differences among the parameters measured; the percent Dust level shows a significant ($p<0.05$) difference among different level of starch inclusion. Highest percent of dust was recorded at 0% level of starch and lowest in pellets with 20% level of inclusion. The pellet ability among starch level also showed significant ($p<0.05$) difference, with highest percent pellet ability in 0% level of starch inclusion and lowest in 15% level of inclusion. Also there was a significant ($p<0.05$) difference in level of starch inclusion for hardness, pellets with 5% and 10% starch level respectively displayed high resistance to pressure of pentagon nut while pellets with 20% starch level offered the least resistance to pressure of the pentagon nut. There was a significant ($p<0.05$) difference in the water stability as per the level of starch inclusion. Pellets with 5% level of starch inclusion displayed greatest degree of stability while those with 20% level of starch demonstrated the least stability in the water medium. Measurement for the friability indicated no significant ($p>0.05$) difference among starch levels irrespective of the variations in the rpm. However there was a significant ($p<0.05$) difference among rpms irrespective of starch levels. Moreover, friability percentage was found to be highest at 100 rpm) Table 2 and lowest at 40 rpm, which was also significant ($p<0.05$).

DISCUSSION

From the result obtained, it was observed that the feed stability in the pelleted form with respect to its physical characteristics vis; Pellet ability, Hardness, Friability, Dust and water stability, all exhibited high degree of variability regarding different starch levels of inclusion.

As for pellet hardness it exhibited the high degree of hardness (Table 2) at 0% level of starch inclusion, which would be assumed as okay and perhaps the best pellet. But the Dust level was the highest (Table 2), which is an indication for insufficient binder in the feed that resulted In the softness of the pellets (Church and Pond, 1988).

Table 2: Physical parameters of yam starch based feed

	Starch level				
Parameter	0%	5%	10%	15%	20%
Dust	0.12[c]	0.09[bc]	0.09[bc]	0.06[ab]	0.02[a]
Pellet ability	90.11[e]	84.96[d]	80.91[c]	65.75[a]	79.11[b]
Hardness	5.16[c]	5.24[d]	4.16[b]	6.52[d]	3.68[a]
Water stability	46.03[bc]	47.74[d]	46.31[c]	45.74[b]	41.71[a]

Data on the same row carrying different letters differ significantly from each other ($p<0.05$)

Table 3: Friability of yam starch based feed

Rpm	0%	5%	10%	15%	20%
40	0.04[a]	0.05[ab]	0.05[ab]	0.05[ab]	0.05[ab]
63	0.07[abc]	0.07[abc]	0.09[acbdf]	0.09[abcd]	0.10[bcd]
80	0.09[abcd]	0.10[bcd]	0.09[abcd]	0.09[abcd]	0.13[d]
100	0.14[d]	0.12[cd]	0.11[cd]	0.13[d]	0.13[d]

Data on the same row carrying different letters differ significantly from each other ($p<0.05$)

Moreover, at 20% level of starch inclusion, the Dust level was the lowest but lowest percentage of pellet ability was obtained (Table 2). This is due to gumming together of the pellets, which is an indication of over binding, a disadvantage of over starching. The gumming together of the pellet strands is a function of the adhesive property of the binder (Somsveb, 1993; Lim and Dominy *et al*., 1991; Akiyama *et al*., 1989; Stivers, 1970). However, at 5% level of starch inclusion, the best obtainable pellets were achieved. The pellet displayed good pelletablity, hardness, water stability and minimum dust level of 0.9% (Table 2) that would ensure stable pellets that will not easily disintegrate in the aquatic medium (Hardy, 1989; Jobling, 1994; De Silva and Anderson, 1995) and friability was best at 40 rpm and at most 63 rpm but could not withstands rpm as high as 100 rpm (Table 3). Therefore, it can be concluded that the use of Yam starch as binder for fish feed is best at 5% level of inclusion that would ensure the desirable pellets.

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REFERENCES

Akiyama, D.M., W.G. Dominy and A.H. Lawrence, 1989. Penaeid Shrimps nutrition for the commercial feed industry. Proceeding of the Agricultural Feed Processing and Nutrition Workshop, 87: 94-95.

Asiedu, J.J., 1992. Processing Tropical Crops-A Technical Approach, Macmillan Press Ltd London and Basingtoke, pp: 261.

Church, D.C. and W.G. Pond, 1988. Basic Animal Nutrition and Feeding (3rd Ed.). John Wiley and Son, New York, pp: 362-66.

Dominy, G.W., C.B. Keith and F. Charlie, 1991. Mixing and mixer for the aquaculture industry. Proceedings of the aquaculture feed processing and nutrition workshop, Thailand and Indonesia, pp: 158-162.

De Silva, S. and T. Anderson, 1995. Fish Nutrition in Aquaculture. Chapman and Hall, London, pp: 192-197.

Fagbenro, O. and K. Jauncey, 1995. Water stability, nutrient leaching and nutritional roperties of moist fermented fish silage diets. Aqua. Eng., 14: 143-145.

Hardy, R.W., 1989. Diet preparation. In Fish Nutrition, 2nd Edn. J.E. Halver. Academic Press London, pp: 475-548.

Hastings, S.W.H. and A. Higgs, 1980. Feed milling process. In: Fish Feed Technology. AADCP/72/REP/80/11, UNDP/FAO, Rome, pp: 293-313.

Jauncey, K., 1992. M.Sc. aquaculture lecture Note in Nutrition, Institute of Aquaculture, University of Stirling, Stirling-UK.

Jobling, M., 1994. Fish Bioenergetics Chapman and Hall, London, pp: 58-60.

Lim, C. and G.W. Dominy, 1991. Performance of binders in pelleted shrimps diet. Proceeding of Aquaculture Feed Proceeding and Workshop, Thailand and Indonesia, pp: 149-157.

Lim, C. and G.W. Dominy, 1991. Performance of binders in pelleted shrimps diet. Proceeding of Aquaculture Feed Proceeding and Workshop, Thailand and Indonesia, pp: 149-157.

Misra, C.K., B.K. Bas and K.N. Mohanta, 2003. Feed Management in Aquaculture-Fish Farmer International, pp: 33.

Natividad, J.M., 1994. Fish nutrition In: Philipine (BFAR) Freshwater Aquatic Extension Training Manual, Vol.III Tech., pp: 67-69.

Orire, A.M., S.O.E. Sadiku and L.O. Tiamioyu, 2001. Suitability of Cassava starch as feed Binder. Science Forum: J. Pure Appl. Sci., pp: 61-65.

Pigott, M.G., N.E. Heck, R.D. Stockard and J.E. Halver, 1982. Special feeds. In: Fish Nutrition (Halver, J.E. Ed.) John Wiley and Son, New York, pp: 657.

Pigott, M.B. and W.B. Tucker, 1989. Special Fedd in fish Nutrition (2nd Ed.). Academic Press.

Sadiku, S.O.E. and K. Jauncey, 1995. Digestibility, apparent amino acid available and waste generation potential of soybean and flour-poultry meat blend based diets for Tilapia *Oreochromis niloticus* (L) fingerlings. Aqua. Res., 26: 651-657.

Sadiku, S.O.E. and K. Jauncey, 1998. Digestibility, apparent amino acid available and waste generation potential of soybean and flour-poultry meat blend based diets for sharp-toothed catfish *Clarias gariepinus* fingerlings. J. Appl. Aqua., 8: 69-81.

Somsveb, P., 1993. Aqua feeds and feeding strategies in Thailand. In: New, M.B., Tacon, A.B.G. and Csavas, I-Eds. Farm-made Aqua feed. FAO/AADCP, Thailand, pp: 365-385.

Steele, G.D.R. and H.J. Torrie, 1960. Principles and Procedures of Statistics. McGraw Hill, London, pp: 633.

Stivers, T.E., 1970. Feed manufacturing. In: Fish feed Technology and Nutrition Workshop. FAO /EIFAC /VSDI/ BSFW. Washington D.C., pp: 14-42.

Tiamiyu, L.O., S.O.E. Sadiku and A.A. Eyo, 2003a. Evaluation of Hydrothermally Processed Full-Fat SoyBeanmeal As Replacement for Fishmeal In the Diets of *Clarias Gariepinus*. J. Sustainable Trop. Agri. Res., 5: 84-89.

Tiamiyu, L.O., S.O.E. Sadiku and A.A. Eyo, 2003b. Growth And Nutrient Utilisation of *Clarias Garipienus* Fed Different Hydrothermally Processed Full-Fat Soybean Diets. J. Sustainable Trop. Agri. Res., 5: 90-96 New York, pp: 656-667.

Viola, S., N. Gur and G. Zohar, 1986. Effects of pelleting temperature, binders and basic grains on water-stability of pellets and on growth of tilapia. Bamidgeh, 37: 19-26.

Wood, J., 1993. Selecting equipment for producing farm made aquafed. In: Farm made Aqua feed (New, M.B., Tecon, A.B.G. and Csavas, 1. Eds.) FAO/AADCP, Thailand, pp: 135-147.

Wood, J.F., 1980. The preparation of water-stable fish feed. 1. Methodology of feed preparation-a brief resume. Trop. Sci. Tech., 18: 1-17.

Zar, J.H., 1984. Biostatiscal Analysis (2nd Ed.). Prentice-Hall, Inc, Englewood Cliffs, New Jersey, pp: 234-236.